

Profile of paediatric tuberculosis mastoiditis – a case series

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Background: Tuberculosis (TB) otitis media is an uncommon site of extrapulmonary TB and can primarily present as a complicated TB mastoiditis (TBM). This complication is rare in children, even in TB endemic areas but necessitates early identification as delays can lead to severe morbidities. We describe the clinical characteristics as a case series to raise awareness of the condition, and highlight fundamentals related to diagnosis and management.

Methods: A retrospective chart review of clinical and radiological information of five children with TBM seen at the Red Cross War Memorial Children's Hospital in Cape Town, South Africa, over the last 5 years. Variables collected included symptomatology, duration of disease, investigations and management.

Results: All were under 5 years of age and presented with typical features of acute bacterial mastoiditis. Mean duration of symptoms was 12 days (range 3–30 days). Two children had known TB contacts. Two children had pulmonary involvement, one with miliary TB. CT of the temporal bone demonstrated extensive bony destruction of the petromastoid and demineralised ossicles in all cases. Three children had intracranial extension. Four children demonstrated hearing loss between 30 dB and 83 dB. Necrotising granulomatous inflammation was present in the mastoid specimens in all cases. Confirmatory diagnosis was made via GeneXpert polymerase chain reaction (PCR) (2), Ziehl-Nielsen (ZN) stain (1) or a positive TB culture (2). Postoperatively, one patient had normal hearing, two patients had mild conductive hearing loss (CHL), one had mild-moderate CHL and one had profound hearing loss.

Conclusion: Delays in identification and management result in marked bony destruction and hearing loss. Radiological and surgical findings typical of TBM, therefore, require tissue sampling from the ear for urgent microscopic, PCR and histologic testing, allowing the avoidance of a mastoidectomy. In a TB endemic setting, children with typical findings and necrotising granulomatous inflammation on histology should be considered for prompt commencement of anti-TB therapy while awaiting a definitive diagnosis.

Keywords: tuberculosis, paediatric, mastoiditis, otology, hearing loss, TB

Introduction

Extrapulmonary TB (EPTB) constitutes about 15–20% of new TB cases in immunocompetent patients and accounts for more than 50% of new TB cases in HIV-positive individuals, potentially affecting any site of the body.¹ Children may be at greater risk of developing EPTB.^{2,3} Diagnosis may be challenging, especially in children, where specimens obtained from relatively inaccessible sites are typically paucibacillary in nature.

Tuberculous otitis media (TOM) is a rare disease and accounts for 4% of head and neck TB.⁴ TOM accounts for 0.05–0.9% of chronic infections of the middle ear.⁵ Not suspecting TOM in children can delay diagnosis and have serious consequences, such as hearing loss and delayed speech and language acquisition, and ultimately undermining neurodevelopment, especially if the disease complicates to a TB mastoiditis (TBM).

Due to the rarity of TBM, published case series are limited to small numbers. Our review subsequently compares agreeably. We present five paediatric cases of TBM, and the

clinical presentations and diagnostic challenges. A suggested management algorithm is proposed.

Methods

A retrospective chart review of children with confirmed TBM was done, managed at the Red Cross War Memorial Children's Hospital in Cape Town, South Africa, over the last 5 years. Variables collected included symptomatology, duration of disease, investigations and management conferred.

Results

Table I presents a summary of patient age, gender and time to presentation, length of follow-up and whether there had been a known TB contact.

Advanced locoregional disease was present in all five cases, with extensive bony destruction and three with intracranial extension. Clinical presentations of all five cases were typical for acute bacterial mastoiditis, presenting with otalgia, purulent otorrhea, anterior displacement of the pinna with postauricular swelling. One child had

Table I: Select basic points

Presentation variables	Individual patients				
	1	2	3	4	5
Age at diagnosis (months)	20	46	12	48	53
Gender	F	F	F	M	M
Time to presentation (days)	14	3	7	4	30
Time from presentation to surgery (days)	3	0	1	0	1
Follow-up (months)	36	6	15	16	1.5
TB contact	No	Yes	No	Yes	No
Constitutional symptoms of TB	No	Yes	No	No	No
TB at another site	No	Yes	No	No	No

constitutional symptoms of cough, fever, and night sweats. Three cases were complex and presented with individual peculiarities. Case 1 presented with postauricular cellulitis but no subcutaneous collection and was clinically well. The child was initially treated with intravenous antibiotics. CT scan identified extensive bony and ossicular destruction and soft tissue opacification of coalesced mastoid air cells into a single non-aerated mastoid cavity (Figure 1). Case 2 had features of miliary and intra-abdominal TB. Case 5 had dual pathology; the child had a 2-year history of otorrhoea most likely from the undiagnosed cholesteatoma, prior to presenting with acute TBM. None had facial nerve pathology, nor labyrinthine fistulae.

Intraoperatively, pale granulation tissue was visualised in all cases. All, but case 5, had frank pus. Bony erosion was observed intraoperatively in all cases (Figures 2) as was necrotising granulomatous inflammation (one with areas of caseation) suggestive of TB on histology (Figure 3).

Table II summarises the radiological (CT) findings. The inner ear was normal in 4/5 cases; case 5 had early erosion of the promontory. Radiological changes for case 5 were extensive and suggested either a destructive cholesteatoma or chronic granulomatous infection seen with TB, both of which were confirmed at surgery. Case 5 also had adjacent intracranial extension owing to the extensive bony erosion.

Intracranial extension was also identified on imaging in two other cases (Figure 4). Neurosurgery managed the small extradural abscesses conservatively.

Table III summarises the microbiology and histology findings. Two tissue samples were sent for GeneXpert PCR and had the quickest diagnostic turnaround time of 3 (case 5) and 4 days (case 1). Ziehl-Nielsen (ZN) staining was positive in one patient (case 2) at day 8. A diagnosis of TB was made on TB culture (including confirmatory polymerase chain reaction (PCR) done on culture isolate) in the remaining two cases and took 11 (case 4) and 23 days (case 3). TB was cultured in all five cases and took an average of 16.8 days (range 13–23 days).

Case 1 had a profound hearing loss of 83 dB post-operatively. Case 2 did not have formal audiometry, but hearing was within normal limits using subjective testing by the Otolaryngologist. Case 3 had persistent otitis media with effusion (OME) and mild-to-moderate hearing loss at 1 year follow-up. Case 4 did not have preoperative audiometry as the child was too unwell but had a mild conductive hearing loss of 30 dB postoperatively. Case 5 had normal free field testing preoperatively and 30 dB conductive hearing loss postoperatively.

Discussion

Three theories are quoted in the literature to describe the pathogenesis of TOM: a) haematogenous transmission; b) direct extension via the eustachian tube, particularly in children who drink *M. bovis* infected milk; and c) direct implantation through a perforation of the tympanic membrane.^{6,7} Non-endemic regions in the developed world have also reported apparent origin of TOM from recent immigrant and/or migrant populations.^{8,9}

Bony destruction of the petromastoid bone and fallopian canal has been reported as occurring more frequently in TBM compared to cholesteatoma.^{10,11} Our series reflected this with marked bony destruction seen (Figures 1 and 2).

Two children had known TB contacts; both had pulmonary involvement, one with miliary TB. Some authors consider it necessary to include contact screening in newer guidelines.^{12,13} Nearly 11% of the contacts of EPTB in one series had active or latent TB infection.¹²

Table II: Radiology

Radiology findings	Individual patients				
	1	2	3	4	5
Postauricular abscess	+	+	+	+	+
Denuded ossicles	+	+	Intact	Intact	+
Otitis media with effusion (OME)	-	-	-	-	-
Petromastoid opacification	+	+	+	+	+
Bony erosion	Posterior rim of petrous bone	+	Cortical bone at level of sigmoid sinus	Mastoid filled with soft tissue	Tegmen and posterior petrous ridge; transverse sinus occlusion
Inner ear: normal	+	+	+	+	-
Intracranial involvement	-	-	-	-	-
• Extradural abscess		+		+	+
• Transverse sinus thrombosis		+		+	+
• Other					+
					Soft tissue intracranial extension

Table III: Microbiology and histology

Microbiology variables	Individual cases				
	1	2	3	4	5
• Pus swab: Ziehl-Nielsen stain	-	+	-	-	-
• AFB (microscopy)	-	-	-	-	+
• Culture	+	+	+	+	+
• Culture positive (no of days later)	16	13	23	11	21
PCR					
• GeneXpert	+	ND	ND	ND	+
• Confirming on culture	NR	NR	+	+	NR
Sensitivity					
• Rifampicin	+	+	+	+	+
• Isoniazid (INH)	+	+	+	+	+
Histopathology of middle ear and mastoid specimens					
• Necrotising granulomatous inflammation	+	+	+	+	+
Time between presentation and confirmation of diagnosis (days)	4	8	23	11	3

AFB – acid-fast bacilli, PCR – polymerase chain reaction, ND – not done, NR – not required



Figure 1: Case 1
Reconstructed coronal CT using bone algorithm demonstrates left-sided bone destruction, destruction of ossicular chain and coalescence of the internal mastoid trabeculations. Soft tissue occupies the coalesced mastoid cavity, middle ear cavity and external auditory meatus. Note blunted and eroded scutum.

In our series, the earliest presentation was 3 days, and the latest presentation was 30 days following onset of symptoms. Awareness of the destructive nature of this disease, particularly in relation to hearing loss, is lacking, with a resultant negative impact on speech acquisition, learning and neurodevelopment. In addition, anti-TB treatment also carries a risk of ototoxicity; hence regular testing is recommended during and following completion of therapy.

High-resolution CT criteria for TBM compared to other forms of mastoiditis have been reported.¹⁴ Key findings included soft tissue filling the entire middle ear cavity with extensive bony erosion and involvement of the ossicles.¹⁴ These features were apparent on CT (Figures 1 and 2). However apparent, these findings are not sufficient to permit commencing empiric TB treatment, as is the case with chest x-ray findings in pulmonary TB.¹⁵

A definitive diagnosis of TB requires identification of acid-fast bacilli (AFBs) on ZN stain; or a positive PCR from tissue samples; or by culturing *Mycobacterium tuberculosis*. Diagnosing TB of the otomastoid air cell system or any

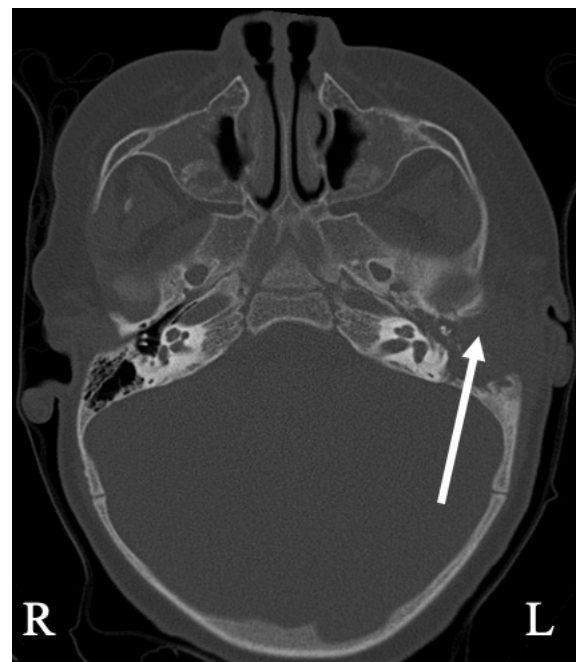


Figure 2: Case 4
Reconstructed axial CT using bone algorithm – demonstrates left bone destruction and coalescence of the internal mastoid trabeculations. Soft tissue occupies the coalesced mastoid cavity, middle ear cavity and external auditory meatus. Note preservation of the incudomalleolar articulation.

EPTB site is challenging because of the paucibacillary nature of the disease in tissue samples.¹⁶ Conventional smear microscopy of ear tissue specimens has a low sensitivity with a range of 0–40%.¹⁶ At our institution, samples sent for GeneXpert PCR have the fastest turnaround time and permit early treatment. ZN staining was positive in one patient but took 8 days. TB culture took 11 and 23 days, resulting in a delay to initiate anti-TB treatment. Yields for culture-positive mycobacteria vary between 30–80%, but usually takes 2–8 weeks to obtain.¹⁶

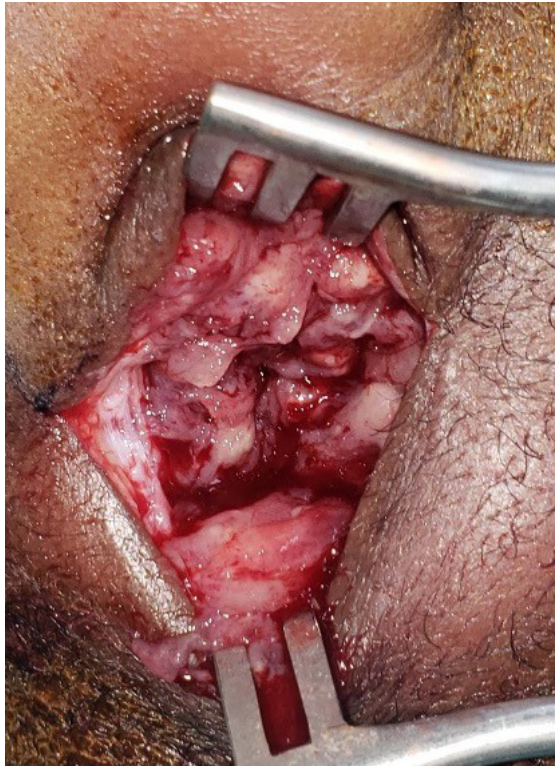


Figure 3: Pale granulation tissue in mastoid bowl at surgery

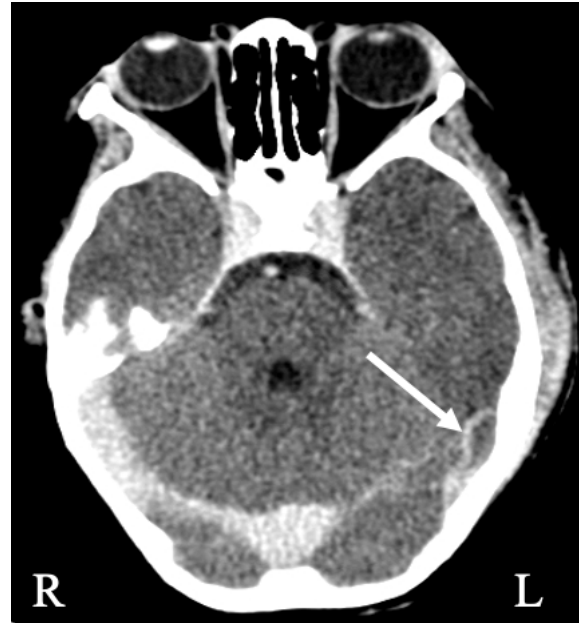


Figure 4: Case 4
Contrast-enhanced axial CT scan – left TOM complicated by an intracranial, extradural rim-enhancing abscess. No adjacent brain parenchymal invasion or left transverse sinus thrombosis.

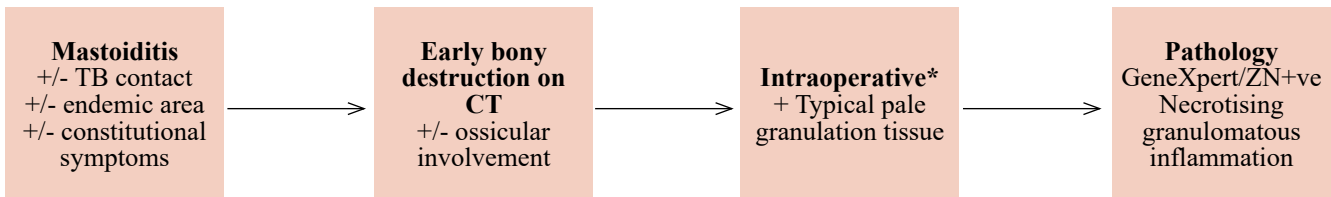


Figure 5: Suggested algorithm for early diagnosis of TB mastoiditis

* With clear intraoperative findings, commencing anti-TB therapy promptly in TB endemic settings can be discussed with institutional infectious disease and/or TB experts with local experience managing EPTB.

Histopathological analysis of surgically obtained tissue is diagnostically the most reliable.⁷ Histology may reveal typical granulomas with caseous necrosis and epithelioid and multinucleated Langerhans-type giant cells.^{7,17} A diagnosis of TB is made on histology if necrotising granulomatous inflammation is present and ZN stain is positive. All 5 cases demonstrated these typical histological features and were reported as highly suggestive of TB, despite AFBs only being seen in case 5. This is likely due to the paucibacillary nature of TB in children and correlates with negative ZN stains on initial microscopy. Pathologists do not routinely carry out a confirmatory PCR. This is done only in specific cases with high suspicion for TB with suggestive histology, but where multiple ZN stains are negative. In our series, a confirmatory PCR was required in case 3 and 4.

A high index of suspicion for TB is crucial for intraoperative decision making, particularly in highly endemic regions. TBM is essentially managed medically, and not surgically, and inappropriate extensive mastoid surgery should therefore be avoided. Typical surgical findings, i.e. pale granulation tissue in the mastoid and middle ear (Figure 3), should prompt the surgeon to limit surgery to simple drainage of the acute abscess, and multiple biopsies for microscopic and histologic analysis, including PCR

(GeneXpert). In cases suspicious of TOM and not presenting with an acute mastoiditis, otoscopic evaluation of the middle ear may facilitate representative tissue sampling. This minimally invasive endoscopic approach may avert poor wound healing and fistula formation seen with TB.

Although generally not recommended, starting empiric anti-TB therapy can mitigate delays in histology and/or culture turnaround times in children with advanced local disease (Figure 5).

Conclusion

TOM is uncommon, TBM even more so, and a high index of suspicion is required in children with ear complaints presenting with constitutional TB symptoms and a positive TB contact. A lack of awareness of TOM and complications thereof, may delay referral for specialist care and hence delay treatment. The clinical course of TOM in children is variable and includes locoregional complications. Audiometric assessment is required to identify hearing loss both because of TOM and TB treatment. Radiological and surgical findings typical of TBM require tissue to be sampled for urgent microscopy, culture and sensitivity, histology and PCR (GeneXpert) testing. GeneXpert PCR

provides the quickest diagnosis. In a TB endemic setting when ZN staining is negative or GeneXpert PCR facilities are lacking, a TB expert should be consulted about initiating anti-TB treatment when there are typical intraoperative findings and accompanying histological features of granulomatous inflammation with central necrosis, together highly suggestive of TBM. Children with confirmed TOM should be investigated for pulmonary TB, and TB contacts should be traced.

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Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

The study was approved by the University of Cape Town Human Research Ethics Committee (HREC Ref 298/2017).

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